COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
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GLEN ALLEN QUADRANGLE

GEOLOGY OF THE GLEN ALLEN QUADRANGLE, VIRGINIA

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UNIT CHARACTERISTICS WITH GEOLOGIC AND ECONOMIC FACTORS AFFECTING LAND MODIFICATION

CENOZOIC — TERTIARY AND QUATERNARY

al — Alluvium: *Floodplain deposits of poorly sorted gray gravel, stratified sand, silt, and clay.*

Subject to periodic flooding; seasonally perched water table; unstable in deep cuts or excavations; severe limitations for construction due to flooding; potential source of topsoil.

g2 — Sand and gravel: *Yellowish-gray to reddish-brown sand with minor amounts of gravel; particle sizes range from clay to cobbles with fine sand dominating; locally finely laminated, mottled with iron oxide or cross-bedded; gravels contain rounded quartz pebbles with sandy to clayey sand matrix, commonly stained by iron oxide; pebbles compose up to 25 percent of deposit, average size 1.5 inch (3.7 cm); locally bedded.*

Deep to very deep, somewhat poorly drained, silty-sandy soil; moderate permeability; depth to granite saprolite ranges from a few inches to 30 feet (9.2 m); may have a fragipan at depths of 25 to 40 inches (64-102 cm); seasonally high water table; moderate to severe limitations for septic tank drain fields, basements, sanitary landfills; not stable in deep cuts or excavations; fair for lawns and landscaping; fair to good for ponds; gravel may be locally abundant at surface causing difficulty with lawns.

g1 — Gravel: *Abundant, well-rounded pebbles and cobbles in a sandy to clayey sand, commonly iron-stained matrix; clasts dominantly of quartz and quartzite with minor clasts of metamorphic and igneous rocks; some quartzite clasts are weathered; clasts may comprise up to 30 percent of the unit and are commonly concentrated on the surface as a residuum of weathering; unit may be composed of thick sandy or silty sand beds in which gravel is rare.*

Discontinuous distribution and variable in thickness; caps hills but may be less than five feet (1.5 m) thick above granite saprolite; gravels make up variable portions of unit and are uncemented; moderate permeability; well-drained; severe limitations for drain fields, ponds, and landfills; moderately stable in deep cuts but unstable in cuts which extend to the underlying saprolite; slight limitations for construction; gravel may be locally abundant at surface causing difficulty with lawns; has been used for fill.

MESOZOIC — TRIASSIC

cm — Newark Group: cm, *coal measures, light- to dark-gray, medium- to coarse-grained arkosic sandstone, dark-gray to black shale, dark-gray siltstone, and coal; arkosic sandstone is thick-bedded and locally contains a few rounded quartz pebbles or carbonaceous clasts; some parts of unit are conglomeratic; coal beds are commonly a few inches thick but some exceed eight feet (2.4 m) in thickness; sandstone weathers brown to reddish-brown; shale weathers brownish-red.*

Shale: thick clayey impermeable soil and saprolite; poorly drained; seasonally high water table; severe limitations for drain fields, foundations, and excavations. Sandstone: soil and saprolite thin on slopes with depth to bedrock often less than 10 feet (3.0 m); moderate permeability; locally poorly drained; moderate to severe limitations for drain fields, foundations, and excavations; possible contamination of nearby streams from drain field effluent; ground water is likely to be of poor quality; easily excavated above bedrock but removal of bedrock difficult; resources limited to coal beds.

R̄ds — R̄ds, Stagg Creek Member: *Light-brown to reddish-brown, massive conglomerates and coarse sandstones, minor amounts of blue to gray siltstones. Clasts include granite, biotite gneiss, granite gneiss, and mylonite. Cobble-sized particles are rounded, smaller ones are subrounded.*

Sandstones and conglomerates well consolidated; permeability poor, water flows only along joint sets; difficult to excavate.

cmy — Cataclastic rocks: *Dark-gray to gray-green, mylonite and ultramylonite in the northwest; usually fine-grained with well-developed fluxion structure and small feldspar porphyroclasts; highly jointed; weathers yellowish gray. Gray to gray-green protomylonite, mylonite gneiss, and blastomylonite in the central area; feldspar augen and rounded porphyroclasts in a finer-grained gray matrix of quartz, biotite, and feldspar; fluxion structure locally well-developed; highly jointed where finer-grained; weathers yellowish gray.*

Deep to very deep, well-drained soil; depth to firm rock ranges from 3 to more than 25 feet (0.9 to 7.6 m), usually more than 15 feet (4.6 m); permeability moderate in the topsoil, moderately low in the subsoil; subsoils sticky, plastic, and difficult to move when wet; subsoil permeability may limit use of septic tank drainfields or require special design; moderate limitations for septic tank drain fields, ponds, and sanitary landfills; stable in deep cuts or excavations; slight limitations for homesites, foundations, roadways, lawns; rocks are commonly poor water supply sources; topsoil is fair to poor for landscaping; rocks yields excellent crushed stone.

PALEOZOIC

Pzpb / pq — Petersburg granite: Pzpb, *fine- to coarse-grained, uniform to porphyritic, foliated to non-foliated granite, granodiorite, and minor quartz monzonite.* pq, *closely jointed, highly fractured granite with numerous quartz and pegmatite veins filling the fractures; locally brecciated with some slickensides on fracture surfaces; possible shear zone.*

Deep to very deep, well-drained soil; clay seams in saprolite; soil and saprolite with moderate to high permeability; bedrock impermeable; depth to bedrock variable from 6 to 60 feet (1.8-18.2 m); subsoil slightly sticky and plastic when wet; moderate limitations for drain fields and ponds; excavation requires power equipment, blasting required for bedrock; saprolite thickest on upland surfaces, thinner on steep slopes; abundance of joints highly variable; relatively stable in excavations; slight limitations for construction; potential source of topsoil except in quartz-rich zones; suitable for crushed stone and equigranular rock has been used as a dimension stone; saprolite has been used as fill.

PRECAMBRIAN (?)

bg — Biotite gneiss: *Dark gray, fine- to medium-grained, well-foliated biotite gneiss with minor interlayered plagioclase gneiss; commonly well-jointed and cut by thin quartz veins and pegmatite dikes.*

Deep to moderately deep, moderately well to somewhat poorly drained soil; depth to firm rock varies from 5 to over 20 feet (1.5 - 6.1 m); characteristics vary with mafic mineral content; where rock is low in biotite, soil is well-drained with moderate permeability, has slight limitation for septic tank drain fields, ponds, and sanitary landfills and is good for homesites, basements, foundations, and roadways; where parent rock is biotite-rich, subsoil is clayey with low permeability and has moderate to severe limitation for septic tank drain fields, homesites, foundations, roadways, and sanitary landfills, and is good for ponds; subsoil may have a high swell potential and be sticky, plastic, and difficult to compact and move when wet; deep cuts and excavations tend to be unstable when soil is wet; removal of bedrock requires blasting.

KEY

CONTACTS

- Exposed or approximate
- Covered or inferred

FAULTS

- U / D — Approximate (black line); covered (gray line); U, upthrown side; D, downthrown side

ATTITUDE OF ROCKS

- 19 — Strike and dip of beds
- 87 — Strike and dip of joints
- Strike of vertical joints

FOLIATION

- 24 — Strike and dip of foliation
- 11 — Direction and angle of plunge of lineation

QUARRIES

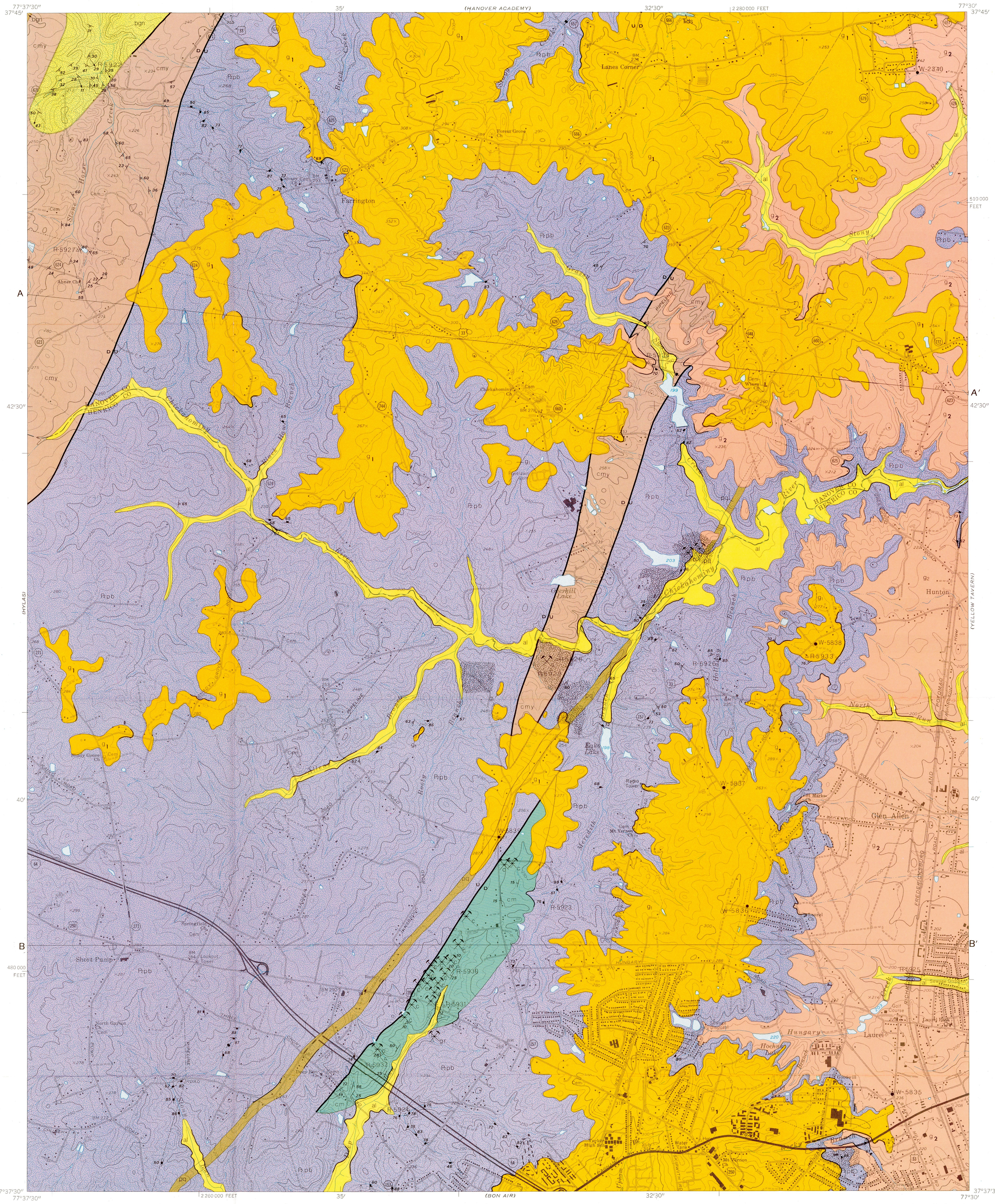
- s — Active crushed stone quarry; Tidewater Quarry, Inc.
- b — Abandoned borrow pit in Petersburg granite saprolite
- gr — Abandoned quarry in Petersburg granite
- c — Abandoned coal mine or prospect pit

SAMPLE LOCATIONS

- △ R-5932 — R, repository number of rock sample on file at Virginia Division of Mineral Resources

WELL LOCATIONS

- ● W-5839 — W, repository number of sampled water wells on file at Virginia Division of Mineral Resources



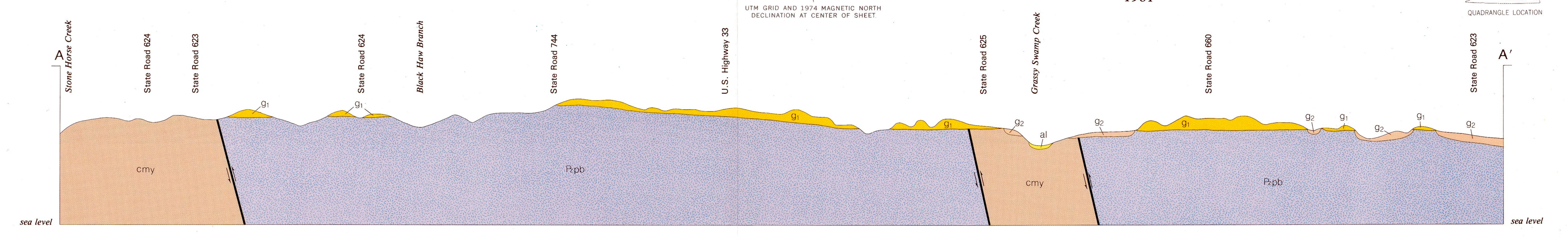
Base map from U.S. Geological Survey, 1963 (74-PR)
Glen Allen Quadrangle, 7½ Minute Series

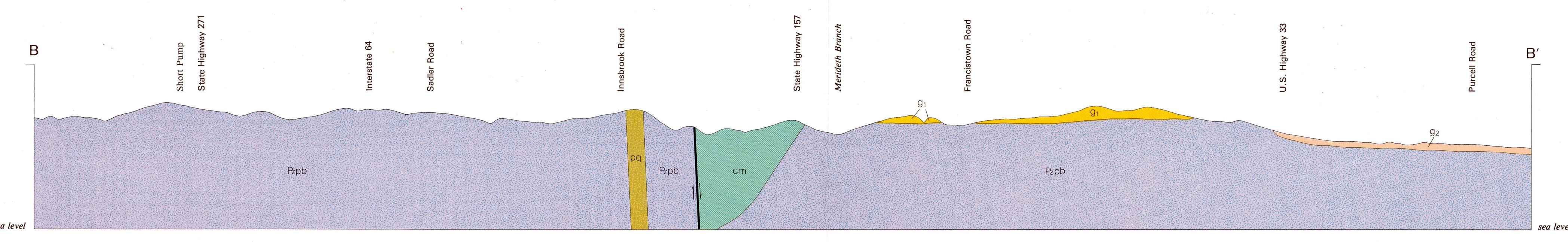
SCALE 1:24 000

CONTOUR INTERVAL 10 FEET

1981

CROSS SECTION DESIGN
1. Vertical exaggeration X10.
2. Subsurface structure interpreted from surface measurements.
3. Thickness of terrace deposits and alluvium approximate.





The Glen Allen 7.5-minute quadrangle is at the extreme eastern edge of the Piedmont physiographic province and lies astride the Fall Zone, which separates the igneous and metamorphic rocks of the Piedmont from the sediments of the Coastal Plain province. Nonmarine sand, clay, and gravel overlie eroded Piedmont lithologies in the eastern quarter of the area at the edge of the Coastal Plain proper. A thin veneer of gravels capping several of the higher hills extends westward over the Piedmont surface. Crystalline rocks continue eastward beneath the Coastal Plain cover and form the "basement complex." A small portion of the Triassic lowland subprovince is represented in the quadrangle by a narrow basin of Triassic sedimentary rocks. These rocks are along Deep Run in the south-central portion of the quadrangle. Most of the topography is mature and is characterized by low, gently rolling terrain. Near the eastern margin of the quadrangle, an area underlain by Coastal Plain sediments, the land surface is dominated by a surface sloping gently eastward. Many streams flow north-northeastward, paralleling the structural grain of the underlying bedrock. Total relief south of the Chickahominy River is about 180 feet (54.9 m) and north of the Chickahominy River it is about 190 feet (57.9m).

Deep weathering of crystalline and of Triassic sedimentary rocks has produced a deep residual soil that is thickest on hilltops and thinner on slopes. Bedrock outcrops are rare except along streams, so most observations are on saprolite or on highly decomposed rock.

STRATIGRAPHY

PRECAMBRIAN OR LOWER PALEOZOIC ROCKS

Biotite Gneiss

Biotite gneiss (R-5922) occurs only in the northwestern corner of the quadrangle; it is bounded east, west, and south by cataclastic rocks and is well exposed along Stone Horse Creek and one of its tributaries. The gneiss is dark gray where fresh and is fine- to medium-grained. Dark- and light-gray zones are interlayered; the darker zones have less plagioclase. Dominant minerals in the gneiss are quartz, biotite, plagioclase, and potassium feldspar. Locally, epidote may be abundant and the biotite has largely been retrograded to chlorite. Accessory minerals include garnet, magnetite, apatite, and sphene. The feldspars and quartz are usually anhedral; the quartz shows moderate to severe straining. Similar gneisses in the Hanover Academy quadrangle were, perhaps, originally graywackes (Weems, 1974). Foliation is well developed and some foliation planes are crenulated. The gneiss commonly has numerous well-developed joints. It is cut in a few places by thin pegmatite dikes. The gneiss is generally deeply weathered to form a clay-rich, deep-red, banded saprolite.

The age of the unit is uncertain, but because xenoliths of similar gneiss occur within the Petersburg granite, it is thought to be older than the Petersburg. Bobyarchick (1976) considered this gneiss to be correlative, in part, with the Maidens Gneiss, which is in Goochland County, about 30 miles (48 km) to the west. The Maidens Gneiss was correlated with the Wissahickon Formation by Poland (1976) and it thus may be early Cambrian or late Precambrian in age.

UPPER PALEOZOIC ROCKS

Petersburg Granite

The Petersburg granite (R-5923, R-5924, R-5925, R-5926) is the basement rock within the quadrangle except for the area of the Deep Run basin and for the areas of cataclastic rock and gneiss. The unit is locally concealed by a capping of gravel and Coastal Plain sediments. The granite is usually deeply weathered to a saprolite which may be more than 60 feet (18.3 m) thick; the saprolite is usually thickest under the uplands, thinner on slopes, and thinnest on valley floors. Most exposures of relatively unweathered granite occur adjacent to streams.

Three phases of the Petersburg granite were distinguished in the Richmond area (Bloomer, 1939), but these were not mapped in the Glen Allen quadrangle because of poor exposures. Rock composition ranges from granite to granodiorite. The granite commonly contains two feldspars, muscovite, and biotite. Accessory minerals include chlorite, epidote, sphene, zircon, and black opaques. Grain size in the granite ranges from fine to coarse, and textures from uniform to porphyritic. Foliation is absent to well developed. The rock in some exposures is highly jointed and cut by numerous thin quartz, aplite, and pegmatite dikes; in other exposures it is massive. Generally, finer-grained granites are more highly jointed than coarser ones.

A narrow, north-northeast trending zone within the Petersburg granite contains rock which is characterized by numerous fractures and quartz veins and by an abundance of thin pegmatitic dikes. Most of the dikes are only a few inches wide but some are as wide as two feet (0.6 m). Unusual occurrences of quartz in this zone include: botryoidal masses of concentric crystal growth; veins of parallel, elongated crystals; and drusy, vuggy masses of quartz crystals. Slickensides are common on fracture surfaces and quartz veins are offset slightly along some of them. At several localities, and particularly at some in the adjoining Bon Air quadrangle, this zone contains brecciated granite. These rocks and relationships are interpreted as representing a shear zone in the Petersburg granite. The zone has been traced from an area of alluvial cover in the northeast quadrant of the Glen Allen quadrangle south-southwest to the James River, a distance of about 10.8 miles (17.4 km). Even where exposures are lacking, the quartz-rich zone can be traced in many places by an abundance of angular to slightly rounded quartz fragments. These are commonly as large as cobbles and occur within or on top of the soil. The high quartz content of the zone enables it to stand above adjacent granite as elongate, narrow ridges.

Zircons from a medium-grained, massive quartz monzonite in the Richmond area which is believed to belong to the Petersburg granite yielded an age of 330 ± 8 million years (Wright, Sinha, and Glover, 1975). This date may not apply to the entire pluton, which seems to have had a complex history judging from its variable composition and texture.

Cataclastic Rocks

Cataclastic rocks, dominantly mylonites and ultramylonites (as used by Higgins 1971), underlie the northwestern portion of the quadrangle (R-5927) and a long, narrow area within the Petersburg granite west of Meredith Branch (R-5928, R-5929). At the second area, the rocks are well exposed in the pit of Tidewater Quarry Inc., which is northwest of Eako Lake. The rocks from the two areas are similar and are dominantly dark gray to gray green where fresh and are commonly fine grained, dense, and well laminated. Moderate-orangish-pink and white, rounded porphyroclasts of potassium feldspar and plagioclase may be over 2 cm long. A fluxion structure may be well developed where fine laminae of microscopic quartz, muscovite, and chlorite are bent around the porphyroclasts, and in most places the rock is strongly foliated. The rock commonly contains closely spaced joints; some joints have small displacement. The cataclastic rocks are more resistant to weathering than the surrounding granites and are well exposed along streams.

The rocks in the northwestern area are part of the Hylas zone (Weems, 1974; 1981), a belt of cataclastic rocks up to 2 miles (3.2 km) wide and 25 miles (40.2 km) long in the adjoining Hanover Academy, Glen Allen, Hylas and Midlothian quadrangles. The zone extends from near the James River in the Midlothian quadrangle to the northeastern part of the Hanover Academy quadrangle, where it is covered by Coastal Plain sediments. Although originally considered to be aporhyolite (Brown, 1937) or metavolcanic rocks (Goodwin, 1970), the rocks are cataclastic (Firebaugh, 1973; Weems, 1974). The mylonites and ultramylonites of the Hylas zone were not mapped separately.

The cataclastic texture of the rocks in the Tidewater Quarry, Inc. pit were described by Firebaugh, (1974) and Rubenstone (1976). The rocks are chemically similar to the surrounding Petersburg granite and were probably derived from cataclasis of this granite (Rubenstone, 1976). These rocks are well exposed only within the quarry and there is, consequently, some doubt about their mapped extent. The few exposures which occur on strike with rocks in the quarry commonly consist of relatively coarse-grained cataclastic rocks. Where these rocks have been weathered to saprolite, it is difficult to distinguish them from weathered granite. The rocks in the quarry (R-5928, R-5929) range from relatively coarse-grained rocks characterized by moderate-orangish-pink, potassium feldspar augen in a dark-gray matrix of biotite and quartz to fine-grained, gray rocks with small moderate-orangish-pink potassium feldspar porphyroclasts in a matrix of quartz, biotite and feldspar. In most of these rocks potassium feldspar is the dominant mineral and plagioclase, quartz, biotite and muscovite are abundant; black opaque minerals plus apatite and zircon, are accessories. Fluxion structures, bent feldspar twin-laminae, and strained quartz were seen in thin sections. Some recrystallization has occurred and resulting textures at places overshadow cataclastic textures. Recrystallized rocks include protomylonite, mylonite gneiss, and blastomylonite, arranged in order of increasing amount of recrystallization. All the rocks are foliated and the fine-grained rocks tend to break parallel to foliation. They are cut by numerous, closely spaced joints. Several nearly vertical minor faults with displacements of less than a few feet cut the rock.

The cataclastic rocks of the Hylas zone may have formed by retrograde metamorphism due to ductile shearing which occurred during late Paleozoic deformation (Bobyarchick, 1976; Bobyarchick and others, 1976; Bobyarchick and Glover, 1979). Neocrystallization in rocks exposed in the Tidewater Quarry Inc. pit is more complete than in Hylas zone rocks, but because of their general similarity, cataclastic rocks in the areas of Meredith Branch and the Hylas zone are believed to be time equivalents. The time of formation is between 330 and 220 million years ago. The older date is taken from zircons in Petersburg granite, which is the youngest rock unit subjected to cataclasis. The younger date is the age of Triassic border conglomerates and boulder breccias which occur at the western edge of the Richmond basin and which contain fragments of Hylas zone rocks.

TRIASSIC SYSTEM

Newark Group

Sedimentary rocks of the Newark group (R-5930, R-5931, R-5932) are exposed in a narrow basin, the Deep Run basin (Rogers, 1884). The basin, which trends N35°E, is about 2.8 miles (4.5 km) long and has a maximum width of about 0.4 miles (0.64 km). From the width of the basin and average dip of bedding, the maximum thickness of the Triassic rocks is estimated to be about 400 feet (122 m). The eastern border of the basin closely parallels Deep Run for 0.8 mile (1.3 km). Sediments at the northern margin of the basin are exposed in a small stream valley east of Deep Run and south of U.S. Highway 250. There, Triassic rocks consist of weathered, gray, coarse-grained, arkosic sandstone containing a few, widely scattered, well-rounded quartz pebbles; the rocks unconformably overlie deeply weathered Petersburg granite. The contact, which slopes about 10 degrees to the west, is poorly defined; evidently the basal Triassic sediments underwent little transportation. There is no evidence of faulting at this exposure nor at a deep cut at a housing development located between Meredith Branch and State Road 157, where similar sediments unconformably overlie weathered Petersburg granite.

At the western margin of the basin, Triassic sediments were formerly exposed in a borrow pit (now destroyed) located between Three Chopt Road and Interstate Highway 64. A 157-foot-long (47.8 m) measured section of Triassic rocks was made across the floor of the pit approximately at right angles to the sediment-granite contact (Goodwin and Johnson, 1967). Portions of the section were covered. Exposed rocks and approximate thicknesses were: medium- to coarse-grained arkose (10 feet, 3 m); siltstone (5 feet, 1.5 m); shale (50 feet, 15.2 m); coal (7.5 feet, 2.3 m); thinly interbedded siltstone and arkose (16 feet, 4.9 m). Where fresh, the arkose was light to dark gray and the other rocks, except coal, were dark gray to greenish gray to black. The color of the weathered arkose was brown to reddish brown. In a seven-foot-deep weathered cut at the edge of the borrow pit the arkose occupied channels in a thick shale sequence. The Triassic beds had an eastward dip of up to 74°, and were in fault contact with the Petersburg granite. The orientation of the fault plane was strike N45°E; dip 68°SE. The granite at the fault contact bore abundant slickensides and contained much chlorite and some epidote; the Triassic rocks were much contorted adjacent to the fault. The border fault itself was offset for a distance of 76 feet (23.2 m) along a left-lateral cross fault trending N75°W.

A deep well (W-2340) in the northeastern corner of the quadrangle penetrated at least 254 feet (77.4 m) of Triassic rocks beneath a cover of gravel and alluvium. The rocks were dominantly gray, fine- to coarse-grained sandstone with angular grains of quartz and feldspar and minor amounts of muscovite and biotite. There were sand-size fragments of granite and mylonite. This may be a part of a basin with Triassic rocks which lies mainly north of the Glen Allen quadrangle (Weems, 1974; 1981).

The Triassic rocks of the Deep Run basin are probably age equivalent with the lowest Triassic rocks in the Richmond basin, which have been assigned an age of late middle Carnian (late Triassic) on the basis of palynological data (Cornet and others, 1973; Cornet, 1977).

TERTIARY SYSTEM

High-Level Gravels

Coarse gravels (R-5933) occur as a discontinous, highly dissected blanket on upland surfaces and extends into the Hanover Academy and Bon Air quadrangles. The gravel deposits are usually less than 40 feet (12 m) thick and commonly form a thin capping less than five feet (1.5 m) thick on top of granite saprolite. The gravels are well-rounded, dominantly quartz pebbles with a few cobbles in a sandy or clayey sand matrix which are often iron stained. Some pebbles are discoidal and have long dimensions parallel to bedding. The gravels appear to be of fluvial origin. In the Glen Allen quadrangle the basal contact of the gravel unit is variable in elevation. South of the Chickahominy River it is usually between 250 and 280 feet (76.2 to 85.3 m) above sea level and does not exhibit any uniform gradient from west to east. North of the Chickahominy River the basal contact is more irregular. Elevations range from 330 feet (100.6 m) near Farrington to 240 feet (73.2 m) in the eastern part of the quadrangle.

In some areas the basal contact is gradational. The transition is from granite saprolite to reworked saprolite with a few scattered rounded quartz pebbles to gravel. At other places the granite saprolite is channeled and a cobble zone a foot or more thick forms a sharp basal contact.

These high gravels are considered to be Tertiary and are thought to be older than the lower gravels because they appear to have been eroded at their eastern margin before the lower level gravels were deposited. Gravels observed below 250 feet appear to have been derived by colluviation of the higher gravels.

Low-Level Gravels

A thin veneer of sand and gravel (R-5934) overlies an eroded, gently sloping surface of Petersburg granite in the eastern part of the quadrangle. The unit is a featheredge at an elevation of 240 feet (73.2 m), but thickens eastward and is more than 80 feet (24.4 m) thick in the Yellow Tavern quadrangle (Daniels and Onuschak, 1974). In the Glen Allen quadrangle it is at most places less than 20 feet (6.1 m) thick, and consists of yellowish-gray to reddish-brown sediments that range in size from clay to cobbles; sand-size particles dominate. Locally, finely laminated yellowish-gray and light-gray silty fine sand is ten feet (3.0 m) thick. These deposits may be mottled with iron oxide. At other places rounded quartz granules and pebbles occur sparsely within a silty sand or fine sand matrix. At some localities gravel beds several feet in thickness occur within the silty sand, and gravel stringers are common. The gravel beds often contain rounded, iron-stained quartz clasts in a red-brown clayey matrix. Some gravel clasts are unstained; these are in a yellowish-gray, silty sand matrix. Weathering may produce a residual mantle formed of quartz clasts concentrated at the surface. The sand and gravel unit lies unconformably on Petersburg granite, or, more commonly, on saprolite formed from it. The contact between granite and overlying sediment is sharp. It is well exposed in cuts of the Richmond, Fredericksburg and Potomac Railroad about 700 feet (213.4 m) north of the State Road 625 and railroad tracks intersection. There, a coarse-grained granite containing pegmatite dikes and thin quartz veins is unconformably overlain by a gray, coarse-grained arkosic sand; the contact is sharp and undulating. The basal five inches (12.7 cm) of the arkose is a gravel zone containing well-rounded pebbles, and a few cobbles, dominantly of quartz in an arkosic sand matrix. The sand contains gradually less feldspar upward where it is a yellowish-gray, quartz-dominated, fine sand. The higher sand has reddish-brown mottles, clay lenses, and sparse, scattered, rounded quartz pebbles. The rest of the unit is gravel in a reddish-brown matrix.

The relationship between the high and the low-level gravels can be determined in the eastern one-third of the quadrangle south of the Chickahominy River. There, the base of the high-level gravels is at an elevation of 270 feet (82.3 m) and the top of the lower gravel unit is at 240 feet (73.2 m). Granite saprolite is commonly exposed in the intervening 30 feet (9.1 m). The relationships are shown on the eastern end of cross section B-B′.

The geologic history of the two gravel units appears to be as follows. The high-level Tertiary gravels were deposited on a weathered, eroded, and gently inclined and channeled surface of Petersburg granite. Following a rise in sea level to about 240 feet (73.2 m) above its present stand, the 30-foot-high (9.1 m) scarp was cut at the old shoreline. As the sea receded, regressive marine sediments and also fluvial sand and gravel of the lower gravel unit were deposited on the sea-eroded granite surface. This gently eastward-sloping plain lies east of U.S. Highway 33. In the valleys of Chickahominy River, Grassy Swamp Creek, and Stony Run (northeastern part of area), the lower gravel unit is adjacent to the high-level gravels; there is no intervening granite saprolite exposed. Along these valleys, which may have formerly been estuaries, it is possible that the high-level gravel plain was not truncated by the sea. Rather, where high gravels extended down to elevations of 240 feet (73.2 m) or less they were eroded and regraded in the stream channels to form the lower level sand and gravel. Two small hills of Petersburg granite in the northeastern portion of the area were isolated by erosion and left as islands around which regressive nearshore sediments accumulated. These sediments may also represent strandline and fluvial conditions (Daniels and Onuschak, 1974).

QUATERNARY SYSTEM

Alluvium

Floodplains and the valley floors along the Chickahominy River and several smaller streams are mantled by deposits of gray, poorly sorted, gravel, stratified sand, silt, and clay. These areas are commonly moist, subject to periodic flooding, and rich in humus.

ECONOMIC GEOLOGY

STONE

Rocks suitable for crushed stone include rocks from the cataclastic zones and from unweathered Petersburg granite; these represent the major mineral resource in the area. Cataclastic rocks similar to those in the map area are worked extensively for crushed stone in the adjacent Hylas quadrangle where three quarries are now in operation. A quarry owned and operated by Tidewater Quarry Inc. is in the narrow cataclastic belt west of Meredith Branch. Petersburg granite is worked for crushed stone in adjacent quadrangles to the south. The abundant sources of crushed stone in the area are sufficient to supply the growing needs of Richmond as suburbs of the city are extended to the west.

The Petersburg granite was much used as a dimension stone at the turn of the century when eighteen quarries were operated in and around Richmond (Watson, 1906; 1910). A light-gray granite and a finer grained, dark-blue granite were extensively used for monument stone (Watson, 1910, p. 93). Both types of granite are homogenous and equigranular. Similar granites in the Glen Allen quadrangle are mainly deeply weathered, particularly on upland areas away from major streams. There, thick saprolite would have to be removed before fresh rock could be worked. This rock could also be used for crushed stone.

COAL

Several mines were formerly in operation in the Deep Run basin both north and south of U.S. Highway 250 to the west of Deep Run. Most of the mining here was done before the 1860's. The latest attempt at coal mining in this basin was in 1938-39 when a shaft was sunk near State Road 157. Records of production from that endeavor are not available but three coal beds, each over eight feet (2.4 m) thick, were reported and the coal was said to be a good quality bituminous (*Richmond Times Dispatch*, Dec. 4, 1938). Many old prospect pits, shafts, and heaps of coal mining waste can be found in this area. The area of the basin is gradually being covered by housing developments and it is unlikely that the coals will be further worked.

This coal is probably correlative with that of the Richmond basin in the Hylas and Midlothian quadrangles to the west. There, good quality bituminous coal once supported an active mining industry (Roberts, 1928; Goodwin 1970).

CLAY MATERIALS

Clay has not been worked in this area but it has been in adjacent areas. Saprolite clay of the Petersburg granite in the Richmond quadrangle has good potential for face brick. It is brown and has only 10 percent total shrinkage at 2000°F (slow firing), no drying defects, and good dry strength (Daniels and Onuschak, 1974, p. 38). Large reserves of similar deeply weathered granite saprolite occur within the Glen Allen quadrangle. Locally it is covered by an overburden of gravel but this is commonly thin.

Tests on clay obtained from shales in the Triassic coal measures of the Richmond basin along Gayton Road in the Midlothian quadrangle indicate that the clay has potential use in the manufacture of face brick and structural tile (Johnson and Tyrrell, 1967, p. 87). Clays derived from weathered shales in the Deep Run basin may be suitable for similar purposes.

Clay in the lower Tertiary sand and gravel is very thin in the Glen Allen quadrangle, but thickens eastward where it was exploited for brick clay in times past (Darton, 1911).

ENVIRONMENTAL GEOLOGY

The units shown on the geologic map are used as the basis for summarizing the environmental geology of the area. Field observations on the lithology, rock fracturing, slope stability, and ease of erosion were considered in conjunction with soil surveys of Henrico County (Clay, 1975) and Hanover County (Hodges, 1975). The northern one-half of the Glen Allen quadrangle is primarily occupied by farms and woodland, but the southern half is rapidly undergoing extensive development for housing and commercial purposes. The terms "slight," "moderate," and "severe" are used to indicate the degree to which the surficial and near surface material is suitable for a designated land use. "Slight" is used to indicate soils which, in most places, will be satisfactory for the designated use. "Moderate" means that the soil may or may not be satisfactory for the designated use. On-site investigations may be necessary to determine potential uses. "Severe" means that in most cases the unit will not be satisfactory for the designated use. Any particular site development or proposed land modification should be preceded by a detailed on-site investigation by a professional geologist or engineer.

REFERENCES

Bloomer, R. O., 1939, Notes on the Petersburg granite: Virginia Geol. Survey Bull. 51, p. 137-145.
Bobyarchick, A. R., 1976: Tectogenesis of the Hylas zone and eastern Piedmont near Richmond, Virginia: unpublished M.S. Thesis, Virginia Polytechnic Institute and State University, 121 p.
Bobyarchick, A. R., Glover, L., III, Weems, R. E., and Goodwin, B. K., 1976, The Hylas "volcanic" rocks northwest of Richmond are cataclastically retrograded gneisses (abs.): Geol. Soc. Amer. Abst. with Programs, vol. 8, no. 2, p. 138-139.
Bobyarchick, A. R. and Glover, L., III, 1979, Deformation and metamorphism in the Hylas zone and adjacent parts of the eastern Piedmont in Virginia: Geol. Soc. Amer. Bull., vol. 90, no. 8, pt. 1, p. 739-752.
Brown, C. B., 1937, Outline of the geology and mineral resources of Goochland County, Virginia: Virginia Geol. Survey Bull. 48, 68 p.
Clay, J. W., 1975, Soil survey of Henrico County, Virginia: U.S. Department of Agriculture Soil Conservation Service, 119 p.
Cornet, Bruce, 1977, The palynostratigraphy and age of the Newark Supergroup: Unpublished Ph.D. Thesis, The Pennsylvania State University, 505 p.
Cornet, Bruce, Traverse, Alfred, and McDonald, N. G., 1973, Fossil spores, pollen, and fishes from Connecticut indicate early Jurassic age for part of the Newark Group: Science, vol. 182, no. 4118, p. 1243-1247.
Daniels, P. A., Jr., and Onuschak, Emil, Jr., 1974, Geology of the Studley, Yellow Tavern, Richmond, and Seven Pines quadrangles, Virginia: Virginia Division of Mineral Resources Rept. Inv. 38, 75 p.
Darton, N. H., 1911, Economic geology of Richmond, Virginia and vicinity: U.S. Geol. Survey Bull. 483, 48 p.
Firebaugh, J. C., Jr., 1973, An alternate interpretation for the origin of a "metavolcanic" unit near Hylas, Virginia (abs.): Virginia Jour. Sci., vol. 24, no. 3, p. 156.
__________, 1974, Possible cataclasis in the Petersburg granite near Glen Allen, Virginia (abs.): Virginia Jour. Sci. vol. 25, no. 2, p. 91.
Goodwin, B. K., 1970, Geology of the Hylas and Midlothian quadrangles, Virginia: Virginia Division of Mineral Resources, Rept. Inv. 23, 51 p.
__________, 1980, Geology of the Bon Air quadrangle, Virginia: Virginia Division of Mineral Resources Publication 18, text and 1:24,000 scale map.
Goodwin, B. K., and Johnson, G. H., 1967, Geologic structures and stratigraphy of a portion of the Triassic basin at Deep Run, Henrico County, Virginia (abs.): Virginia Jour. Sci., vol. 18, no. 4, p. 185.
Higgins, M. W., 1971, Cataclastic rocks: U.S. Geol. Survey, Prof. Paper 687, 97 p.
Hodges, R. L., 1975, Soils of Hanover County, Virginia: Extension Division Virginia Polytechnic Institute and State University, Report 17, 363 p.
Johnson, S. S., and Tyrell, M. E., 1967, Analysis of clay and related materials—eastern counties: Virginia Division of Mineral Resources, Min. Res. Rept. 8, 232 p.
Poland, F. B., 1976, Geology of the rocks along the James River between Sabot and Cedar Point, Virginia: Unpublished M. S. Thesis, Virginia Polytechnic Institute and State University, 99 p.
Roberts, J. K., 1928, The geology of the Virginia Triassic: Virginia Geol. Survey Bull. 29, 205 p.
Rogers, W. B., 1884, A reprint of annual reports and other papers on the geology of the Virginias: New York, D. Appleton and Co., 832 p.
Rubenstone, J. L., 1976, Chemical composition of mylonites in the Piedmont of east central Virginia: Unpublished Honors Thesis, College of William and Mary, 34 p.
Watson, T. L., 1906, Lithological characters of the Virginia granites: Geol. Soc. Amer. Bull., vol. 17, p. 523-540.
__________, 1910, Granites of the southeastern Atlantic States: U.S. Geol. Survey, Bull. 426, 282 p.
Weems, R. E., 1974, Geology of the Hanover Academy and Ashland quadrangles, Virginia: Unpublished M.S. Thesis, Virginia Polytechnic Institute and State University, 97 p.
__________, 1981, Geology of the Hanover Academy quadrangle, Virginia: Virginia Division of Mineral Resources Publication 30, text and 1:24,000 scale map.
Wright, J. E., Sinha, A. K., and Glover, L., III, 1975, Age of zircons from the Petersburg granite, Virginia; with comments on belts of plutons in the Piedmont: Amer. Jour. Sci., vol. 275, p. 848-856.

REFERENCE NOTE

Portions of the publication may be quoted if credit is given to the Virginia Division of Mineral Resources. It is recommended that reference to this report be made in the following form:
Goodwin, B. K., 1981, Geology of the Glen Allen quadrangle, Virginia: Virginia Division of Mineral Resources Publication 31, text and 1:24,000 scale map.

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